

CHROMOSOME STUDIES IN AMERICAN PANICEAE (POACEAE, PANICOIDEAE)¹

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ABSTRACT

Chromosome numbers and meiotic behavior of 60 individuals of American Paniceae, Poaceae, are provided, including six previously uncounted species: *Axonopus andinus* G. A. Black ($2n = 20$), *A. iridifolius* (Poepp.) G. A. Black ($2n = 20$), *Dichanthelium hebotos* (Trin.) Zuloaga ($2n = 18$), *Paspalum geminiflorum* Steud. ($2n = \text{ca. } 20$), *P. heterotrichon* Trin. ($2n = 20$), and *Setaria tenacissima* Schrad. ex Schult. ($2n = 36$). Of the remaining 54 counts, 17 correspond to new ploidy levels in species of *Echinochloa* P. Beauv., *Eriochloa* Kunth, *Hymenachne* P. Beauv., *Panicum* L., *Parodiophyllochloa* Zuloaga & Morrone, *Paspalum* L., and *Setaria* P. Beauv., and 37 are confirmations of previous reports.

Key words: America, chromosome numbers, Paniceae, Panicoideae, Poaceae.

Chromosome numbers have proved to be of great value in understanding the evolution of vascular plants (Raven, 1975), particularly with regard to polyploid taxa (Davidse et al., 1986). Although polyploidy is a common feature in the Poaceae, karyological studies are still lacking in many tropical and subtropical grasses (Honfi et al., 1991), thus limiting our ability to understand the patterns of chromosome change across the family. This paper continues a series focusing on chromosome numbers of Panicoideae (Morrone et al., 1995a, 2006; Hunziker et al., 1998). The purpose of this work is to increase the cytological knowledge of species of Panicoideae collected in different regions of South America. Chromosome numbers were compared with those in previous reports in the Poaceae, included in the following indexes: Ornduff (1967, 1968, 1969), Bolkhovskikh et al. (1969), Moore (1970, 1971, 1972, 1973, 1974, 1977), Goldblatt (1981, 1984, 1985, 1988), and Goldblatt and Johnson (1990, 1991, 1994, 1996, 1998, 2000, 2006).

MATERIALS AND METHODS

One population (with only one individual per population) was analyzed for each species studied, except in *Eriochloa punctata* (L.) Desv. ex Ham., *Paspalum denticulatum* Trin., *P. pilosum* Lam., *P. plicatulum* Michx., and *P. robustum* (Hitchc. & Chase) S. Denham, for which four, five, two, two, and two populations were sampled, respectively.

All chromosome counts were made from slide preparations of microsporocytes and root tip cells. Inflorescences and root tips were fixed with Carnoy's solution (6 parts ethanol:3 chloroform:1 acetic acid) in the field; individual anthers and root tips were squashed in 2% iron propionic hematoxylin (Sáez, 1960; Núñez, 1968), with 2% acetic carmine. Five to 10 pollen mother cells and mitotic metaphases per sample were examined using a standard 18 Zeiss microscope (Zeiss, Jena, Germany) equipped with a photographic camera at SI.

A complete list of the species studied including chromosome numbers, meiotic configurations, geographic origin, and voucher specimens is given in Table 1. Voucher specimens and dried herbarium sheets were deposited at the Instituto de Botánica Darwinion (SI, with duplicates at CTES, LPB, MO, and VEN).

RESULTS AND DISCUSSION

Counts obtained in our study (Table 1) are discussed below alphabetically by genus, except for *Paspalum* L. species, which are discussed as part of Chase's informal groups (Chase, ined.; Zuloaga & Morrone, 2005). Photomicrographs of representative species from five genera (*Axonopus* P. Beauv., *Eriochloa* Kunth, *Parodiophyllochloa* Zuloaga & Morrone, *Paspalum*, and *Setaria* P. Beauv.) are shown in Figure 1.

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Table 1. Chromosome numbers and chromosome associations in species of American Paniceae.

Taxa	Configurations observed in diakinesis of metaphase I and mitotic metaphase	Origin and voucher
<i>Axonopus andinus</i> G. A. Black*	10 II	BOLIVIA. La Paz : Nor Yungas, camino de Yolosa a La Paz, vía carr. antigua Los Yungas Coroico-La Paz, <i>Morrone & Belgrano 4904</i> (CTES, LPB, MO, SI)
<i>A. chrysoblepharis</i> (Lag.) Chase	10 II	BOLIVIA. Santa Cruz : Ñuflo de Chávez, Rta. Nac. 10, ca. Km 97, camino de San Javier a Concepción, <i>Morrone & Belgrano 4956</i> (CTES, LPB, MO, SI)
<i>A. iridifolius</i> (Poepp.) G. A. Black*	10 II	BOLIVIA. La Paz : Nor Yungas, camino de Unduavi a Coroico por la carr. nueva Los Yungas, ca. Km 67, <i>Morrone & Belgrano 4843</i> (CTES, LPB, MO, SI)
<i>A. scoparius</i> (Flüggé) Kuhlman	10 II	BOLIVIA. La Paz : Nor Yungas, camino de Unduavi a Coroico por la carr. nueva Los Yungas, <i>Morrone & Belgrano 4832</i> (CTES, LPB, MO, SI)
<i>A. siccus</i> (Nees) Kuhlman	10 II	BOLIVIA. La Paz : Nor Yungas, camino de Unduavi a Coroico por la carr. nueva Los Yungas, ca. Km 67, <i>Morrone & Belgrano 4841</i> (CTES, LPB, MO, SI)
<i>Dichantherium hebotos</i> (Trin.) Zuloaga*	9 II	BOLIVIA. La Paz : Nor Yungas, ca. 10 km de Challá camino a Caranavi, <i>Morrone & Belgrano 4880</i> (CTES, LPB, MO, SI)
<i>D. viscidellum</i> (Scribn.) Gould	18 II	VENEZUELA. Aragua : Colonia Tovar, cerca del Monum. Nat. Pico Codazzi camino a Colonia Tovar, <i>Morrone et al. 4674</i> (MO, SI, VEN)
<i>Digitaria ciliaris</i> (Retz.) Koeler	18 II	BOLIVIA. Santa Cruz : Ñuflo de Chávez, camino de Concepción a San Javier, Rta. 10, Km 73, <i>Morrone & Belgrano 5079</i> (CTES, LPB, MO, SI)
<i>D. filiformis</i> (L.) Koeler var. <i>laevigulumis</i> (Fernald) Wipff	27 II	VENEZUELA. Aragua : Placibel, vía Colonia Tovar por La Victoria, sector Loma Briza, <i>Morrone et al. 4666</i> (MO, SI, VEN)
<i>D. sacchariflora</i> (Nees) Henrard	18 II	BOLIVIA. Santa Cruz : Florida, camino de la Angostura a Samaipata, rta. 60, <i>Morrone & Belgrano 5091</i> (CTES, LPB, MO, SI)
<i>Echinochloa polystachya</i> (Kunth) Hitchc. var. <i>polystachya</i> †	27 II	ARGENTINA. Entre Ríos : Victoria, Viaducto Rosario-Victoria, 20 km de Rosario, <i>Morrone & Giussani 5176</i> (MO, SI)
<i>Eriochloa distachya</i> Kunth	9 II	BOLIVIA. Santa Cruz : Ñuflo de Chávez, 9 km de Concepción camino a S.A. Lomerio, Hda. San Lorenzo, <i>Morrone & Belgrano 4987</i> (CTES, LPB, MO, SI)
<i>E. punctata</i> (L.) Desv. ex Ham.†	9 II	ARGENTINA. Entre Ríos : Islas del Ibicuy, alrededores de Villa Paranacito, <i>Morrone et al. 5199</i> (SI)
<i>E. punctata</i> †	36 II	ARGENTINA. Corrientes : Empedrado, Rta. Nac. 12, Km 958, Ayo. San Lorenzo, <i>Morrone et al. 5328</i> (MO, SI)
<i>E. punctata</i>	18 II	BOLIVIA. La Paz : Nor Yungas, 3 km de Coroico camino a Caranavi, camino a Río Coroico, <i>Morrone & Belgrano 4866</i> (CTES, LPB, MO, SI)
<i>E. punctata</i>	18 II	BOLIVIA. Santa Cruz : Ñuflo de Chávez, camino de Concepción a San Javier, Rta. 10, Km 73, <i>Morrone & Belgrano 5081</i> (CTES, LPB, MO, SI)
<i>Hymenachne donacifolia</i> (Raddi) Chase†	ca. 10 II	BOLIVIA. La Paz : Nor Yungas, alrededores de Quenallata, entre Challa y Coroico, <i>Morrone & Belgrano 4884</i> (CTES, LPB, MO, SI)
<i>Ichnananthus procurrens</i> (Nees ex Trin.) Swallen	ca. 10 II	BOLIVIA. Santa Cruz : Ñuflo de Chávez, 6–8 km de Concepción camino a S.A. Lomerio, <i>Morrone & Belgrano 4971</i> (CTES, LPB, MO, SI)

Table 1. Continued.

Taxa	Configurations observed in diakinesis of metaphase I and mitotic metaphase	Origin and voucher
<i>Mesosetum loliiforme</i> (Hochst. ex Steud.) Chase	16 II	VENEZUELA. Bolívar : Gran Sabana, Parque Nac. Canaima, 6–10 km de Kama–Meru camino a Santa Elena, <i>Morrone et al.</i> 4766 (MO, SI, VEN)
<i>Panicum elephantipes</i> Nees ex Trin.	15 II	ARGENTINA. Entre Ríos : Islas del Ibicuy, Brazo Largo, Rta. Nac. 12 y Río Paraná Guazú, <i>Morrone et al.</i> 5191 (MO, SI)
<i>P. trichanthum</i> Nees†	36 II	BOLIVIA. La Paz : Nor Yungas, 3 km de Coroico camino a Caranavi, <i>Morrone & Belgrano</i> 4863 (CTES, LPB, MO, SI)
<i>Parodiophylloclhoa cordovens</i> (E. Fourn.) Zuloaga & Morrone†	35 II + 2 I	BOLIVIA. La Paz : Nor Yungas, ca. 10 km de Challá camino a Caranavi, <i>Morrone & Belgrano</i> 4880 (CTES, LPB, MO, SI)
<i>Paspalum alcalinum</i> Mez	9 II	ARGENTINA. Corrientes : Saladas, Rta. Nac. 12, 60 km de Bella Vista camino a Empedrado, <i>Morrone et al.</i> 5322 (MO, SI)
<i>P. arundinaceum</i> Poir.†	20 II	VENEZUELA. Guárico : Mata Linda, carr. Chaguaramas–El Tigre, 81 km de Chaguaramas, <i>Morrone et al.</i> 4749 (MO, SI, VEN)
<i>P. arundinellum</i> Mez	1 VIII + 1 IV + 4 II	ARGENTINA. Misiones : San Ignacio, Parque Prov. Teyucuaré, Peñón del Teyucuaré, <i>Zuloaga et al.</i> 8386 (MO, SI)
<i>P. atratum</i> Swallen†	ca. 25 II	BOLIVIA. Santa Cruz : Ñuflo de Chávez, camino de Concepción a San Javier, Rta. 10, Km 73, <i>Morrone & Belgrano</i> 5082 (CTES, LPB, MO, SI)
<i>P. campylostachyum</i> (Hack.) S. Denham	10 II	VENEZUELA. Táchira : 31 km de San Cristóbal camino a Las Delicias, alrededores del Control de Guardia Pabellón, a 2 km de Pabellón, <i>Morrone et al.</i> 4702 (MO, SI, VEN)
<i>P. commune</i> Lillo	20 II	ARGENTINA. Salta : La Caldera, Rta. Nac. 9, camino al Abra de Santa Laura, <i>Zuloaga et al.</i> 8480 (MO, SI)
<i>P. denticulatum</i> Trin.	20 II	ARGENTINA. Jujuy : Dr. M. Belgrano, Sierra de Zapla, <i>Zuloaga et al.</i> 8607 (MO, SI)
<i>P. denticulatum</i>	20 II	ARGENTINA. Jujuy : El Carmen, Abra de Santa Laura a Dique La Ciénaga, <i>Zuloaga et al.</i> 8495 (MO, SI)
<i>P. denticulatum</i>	20 II	ARGENTINA. Salta : Orán, entrada a Ingenio El Tabacal, <i>Zuloaga et al.</i> 8562 (MO, SI)
<i>P. denticulatum</i>	20 II	ARGENTINA. Entre Ríos : Victoria, Viaducto Rosario–Victoria, 20 km de Rosario, <i>Morrone & Giussani</i> 5174 (MO, SI)
<i>P. denticulatum</i> †	10 II	ARGENTINA. Entre Ríos : Islas del Ibicuy, cruce de las rutas Nac. 12 y 14, <i>Morrone et al.</i> 5212 (MO, SI)
<i>P. geminiflorum</i> Steud.*	ca. 10 II	BOLIVIA. Santa Cruz : Ñuflo de Chávez, Rta. Nac. 10, ca. Km 97, camino de San Javier a Concepción, <i>Morrone & Belgrano</i> 4964 (CTES, LPB, MO, SI)
<i>P. heterotrichon</i> Trin.*	10 II	VENEZUELA. Miranda : Área Metro. Parque Nac. El Ávila, camino a Sabas Nieves, <i>Morrone et al.</i> 4739 (MO, SI, VEN)
<i>P. inconstans</i> Chase	30 II	BOLIVIA. La Paz : Murillo, Valle del Zongo, camino de La Paz a Zongo, ca. 7 km de Zongo, <i>Morrone & Belgrano</i> 4805 (CTES, LPB, MO, SI)
<i>P. intermedium</i> Munro ex Morong & Britton	20 II	ARGENTINA. Corrientes : Empedrado, Rta. Nac. 12, Km 958, Ayo. San Lorenzo, <i>Morrone et al.</i> 5327 (MO, SI)
<i>P. ionanthum</i> Chase	20 II	ARGENTINA. Corrientes : San Roque, Rta. Nac. 12, Km 870, 31 km de S Roque camino a Goya, <i>Morrone et al.</i> 5336 (MO, SI)
<i>P. juergensii</i> Hack.	10 II	BOLIVIA. La Paz : Nor Yungas, camino de Unduavi a Coroico por la carr. nueva Las Yungas, <i>Morrone & Belgrano</i> 4831 (CTES, LPB, MO, SI)

Table 1. Continued.

Taxa	Configurations observed in diakinesis of metaphase I and mitotic metaphase	Origin and voucher
<i>P. macrophyllum</i> Kunth [†]	20 II	VENEZUELA. Táchira : ca. 2 km del Sector La Honda camino a Las Delicias, a 18 km del control de Guardia Pabellón, <i>Morrone et al.</i> 4705 (MO, SI, VEN)
<i>P. maculosum</i> Trin.	10 II	BOLIVIA. Santa Cruz : Ñuflo de Chávez, 9 km de Concepción camino a S.A. Lomerio, Hda. San Lorenzo, <i>Morrone & Belgrano</i> 4985 (CTES, LPB, MO, SI)
<i>P. malmeanum</i> Ekman	10 II	BOLIVIA. Santa Cruz : Ñuflo de Chávez, 9 km de Concepción camino a S.A. Lomerio, Hda. San Lorenzo, <i>Morrone & Belgrano</i> 4991b (CTES, LPB, MO, SI)
<i>P. microstachyum</i> J. Presl [†]	20 II	VENEZUELA. Cojedes : camino de Tinaquillo a Tinaco, carr. Valencia-San Carlos, Km 59, <i>Morrone et al.</i> 4683 (MO, SI, VEN)
<i>P. multicaule</i> Poir.	2n = 20	VENEZUELA. Portuguesa : carr. Acarigua-Guanare, a 50 km de Acarigua, <i>Morrone et al.</i> 4686 (MO, SI, VEN)
<i>P. penicillatum</i> Hook. f.	20 II	BOLIVIA. La Paz : Murillo, Valle del Zongo, camino de La Paz a Zongo, <i>Morrone & Belgrano</i> 4808 (CTES, LPB, MO, SI)
<i>P. pilosum</i> Lam. [†]	10 II	VENEZUELA. Mérida : Fac. de Cien. Forestales, <i>Morrone et al.</i> 4721 (MO, SI, VEN)
<i>P. pilosum</i> [†]	10 II	VENEZUELA. Bolívar : Gran Sabana, Parque Nac. Canaima, 16 km de Quebrada Pacheco y a 12 km de Yuruaní camino a Santa Elena, <i>Morrone et al.</i> 4778 (MO, SI, VEN)
<i>P. plenum</i> Chase	11 II + 18 I	ARGENTINA. Corrientes : Empedrado, Rta. Nac. 12, Km 958, Ayo. San Lorenzo, <i>Morrone et al.</i> 5330 (MO, SI)
<i>P. plicatulum</i> Michx.	20 II	BOLIVIA. Santa Cruz : Ñuflo de Chávez, 9 km de Concepción camino a S.A. Lomerio, Hda. San Lorenzo, <i>Morrone & Belgrano</i> 4979 (CTES, LPB, MO, SI)
<i>P. plicatulum</i>	20 II	ARGENTINA. Jujuy : La Caldera, Rta. Nac. 9, camino a Abra de Santa Laura, <i>Zuloaga et al.</i> 8477 (MO, SI)
<i>P. regnellii</i> Mez	ca. 10 II	ARGENTINA. Entre Ríos : Concordia, camino de Colonia Ayuí a la Rta. Nac. 14, 3 km de Co. Ayuí, <i>Morrone et al.</i> 5303 (MO, SI)
<i>P. remotum</i> J. Rémy [†]	ca. 20 II	ARGENTINA. Jujuy : Ledesma, Abra de Cañas, camino a Valle Grande, <i>Zuloaga et al.</i> 8522 (MO, SI)
<i>P. repens</i> P. J. Bergius	10 II	ARGENTINA. Entre Ríos : Islas del Ibicuy, Brazo Largo, Rta. Nac. 12 y Río Paraná Guazú, <i>Morrone et al.</i> 5193 (MO, SI)
<i>P. robustum</i> (Hitchc. & Chase) S. Denham [†]	20 II	VENEZUELA. Miranda : Área Metro, Parque Nac. El Ávila, camino a Sabas Nieves, <i>Morrone et al.</i> 4740 (MO, SI, VEN)
<i>P. robustum</i> [†]	40 II	VENEZUELA. Portuguesa : Guanare, predio de la Univer. Nac. Exp. de los Llanos Centrales E. Zamora, <i>Morrone et al.</i> 4694 (MO, SI, VEN)
<i>Pennisetum latifolium</i> Spreng.	18 II	URUGUAY. Tacuarembó : Rta. 26, Km 208, Cañada del Sauce, <i>Morrone et al.</i> 5278 (MO, SI)
<i>P. montanum</i> (Griseb.) Hack.	2 IV + 12 II	BOLIVIA. La Paz : Larecacha, 2 km de Sorata vía el camino por "Altai Oasis," <i>Morrone & Belgrano</i> 4931 (CTES, LPB, MO, SI)
<i>P. nervosum</i> (Nees) Trin.	ca. 18 II	ARGENTINA. Entre Ríos : La Paz, Rta. Nac. 12 y Río Guayquiraró, Km 593, <i>Morrone et al.</i> 5355 (MO, SI)
<i>Setaria tenacissima</i> Schrad. ex Schult.*	18 II	BOLIVIA. La Paz : Nor Yungas, desvío a Yanicucho, a 1 km de carr. nueva Los Yungas La Paz-Coroico, <i>Morrone & Belgrano</i> 4860 (CTES, LPB, MO, SI)
<i>S. vulpiseta</i> (Lam.) Roem. & Schult. [†]	9 II	BOLIVIA. Santa Cruz : Ñuflo de Chávez, camino de Concepción a San Isidro, ca. 3 km antes de San Isidro, <i>Morrone & Belgrano</i> 5023 (CTES, LPB, MO, SI)

Chromosome associations at meiosis: I = univalent, II = bivalent, IV = quadrivalent, and VIII = octovalent.

* Taxa not previously cytologically studied.

[†] Taxa with chromosome numbers that differ from previously published reports.

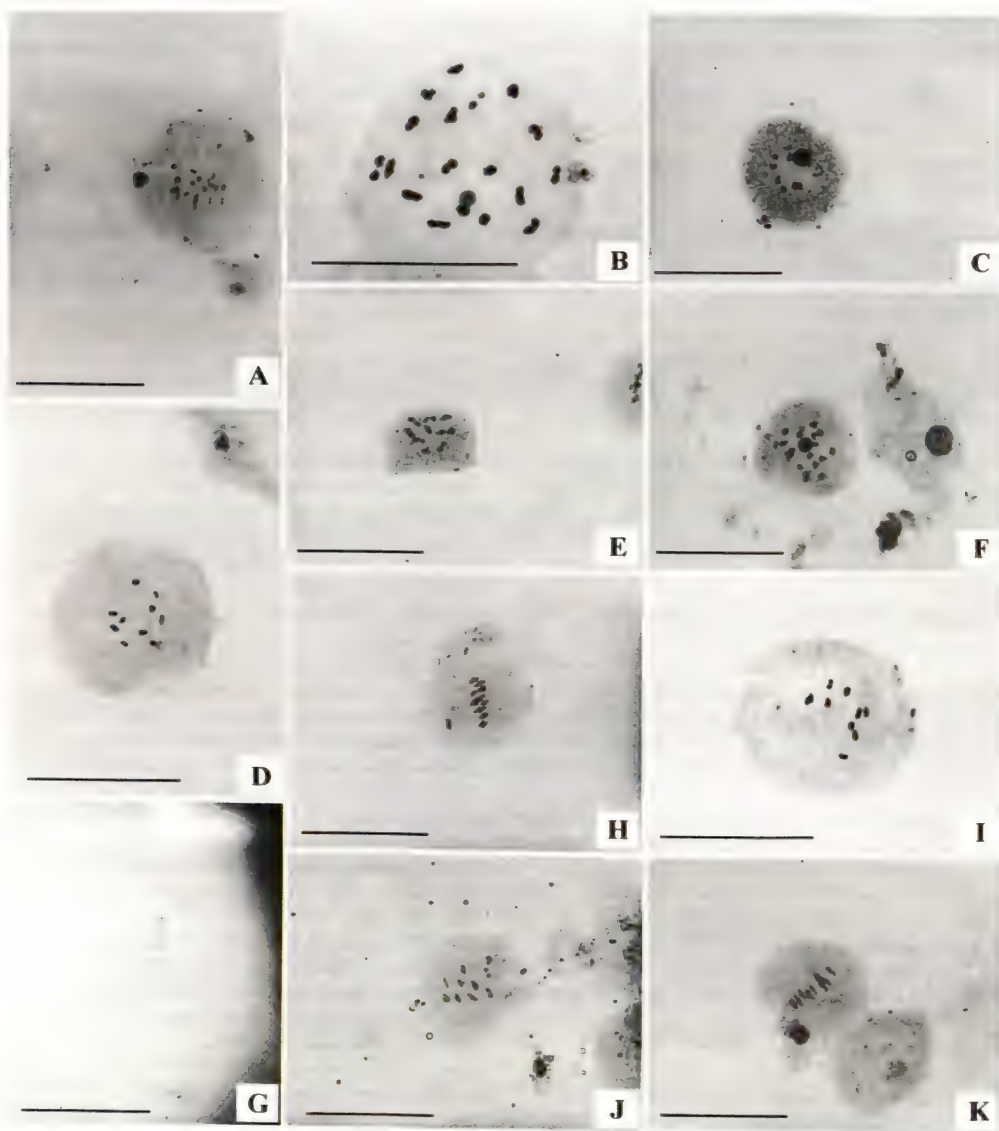


Figure 1. Photomicrographs of meiotic chromosomes of American Paniceae. —A. *Eriochloa punctata* (L.) Desv. ex Ham., 18 II, prometaphase I. —B. *Setaria tenacissima* Schrad. ex Schult., 18 II, late diakinesis. —C. *Axonopus iridifolius* (Poepp.) G. A. Black, 10 II, diakinesis. —D. *Paspalum geminiflorum* Steud., 10 II, prometaphase I. —E. *Paspalum atratum* Swallen, 10 II, diakinesis. —F. *Paspalum macrophyllum* Kunth, 20 II, diakinesis. —G. *Paspalum penicillatum* Hook. f., 20 II, metaphase I. —H. *Parodiophylloclhoa cordovensis* (E. Fourn.) Zuloaga & Morrone, 9 II, metaphase I. —I. *Paspalum heterotrichon* Trin., 10 II, prometaphase I. —J. *Paspalum malmeanum* Ekman, 10 II, early metaphase I. —K. *Setaria vulpiseta* (Lam.) Roem. & Schult., 9 II, metaphase I. Scale bars = 20 μ m.

Axonopus is a large genus of more than 100 species (Black, 1963) confined to the Neotropics, with only one species in Africa; many of the species of the genus are significant components of native pastures. Key diagnostic morphologies for the genus are spikelets solitary, with lower glume and lower lemma toward the rachis. Chromosome numbers of *A. andinus* G. A.

Black ($2n = 20$), a species of subseries *Scoparii* G. A. Black, and *A. iridifolius* (Poepp.) G. A. Black ($2n = 20$) (Fig. 1C), of subseries *Ancipites* G. A. Black (sensu Black, 1963), represent the first cytological report for both taxa. Counts of $2n = 20$ for *Axonopus chrysoblepharis* (Lag.) Chase (section *Cabrera* (Lag.) Chase), *A. scoparius* (Flüggé) Kuhl., and *A. siccus*

(Nees) Kuhlman. (subseries *Barbigeri* G. A. Black) are in agreement with previous reports by Shibata (1962), Pohl and Davidse (1971), Davidse and Pohl (1974), Hickenbick (1975), Norrmann et al. (1994), and Morrone et al. (1995a).

Dichanthelium (Hitche. & Chase) Gould is an American genus with approximately 60 species distributed from Canada and the United States to Argentina and Chile in South America (Zuloaga et al., 2003). The genus includes many species with foliar and floral dimorphism, which are usually present in humid places, such as forest edges or margins of streams and rivers (Gould & Clark, 1978; Crins, 1991; Zuloaga et al., 1993). A high percentage of diploids, ca. 80%, have been reported for North and Central American species of *Dichanthelium* (Dubcovsky & Zuloaga, 1992). The chromosome count of *D. hebotos* (Trin.) Zuloaga ($2n = 18$) is reported here for the first time, while that of *D. viscidellum* (Scribn.) Gould ($2n = 36$) is in accordance with a previous report (under *Panicum viscidellum* Scribn.; Davidse & Pohl, 1974). Both numbers are in agreement with the basic chromosome number proposed for the genus ($x = 9$) (Brown, 1948; Gould, 1966, 1968; Gould & Soderstrom, 1967).

The genus *Digitaria* Haller includes from 200 to 330 species distributed worldwide in tropical, subtropical, and warm temperate regions (Nicora & Rúgolo de Agrasar, 1987; Watson & Dallwitz, 1992). Key diagnostic morphologies for the genus are spikelets with the lower glume small, upper antheridium cartilaginous, with the margins of the lemma flat, not inrolled over the palea. The base chromosome number of the genus is $x = 9$ (Watson & Dallwitz, 1992), and polyploidy is a common feature (Bolkhovskikh et al., 1969; Gould & Soderstrom, 1974; Mehra & Sharma, 1975). Chromosome counts of *D. ciliaris* (Retz.) Koeler ($2n = 36$), *D. filiformis* (L.) Koeler var. *laevigulumis* (Fernald) Wipff ($2n = 54$), and *D. sacchariflora* (Nees) Henrard ($2n = 36$) confirm those of previous reports (Reeder, 1971; Morrone et al., 1995a; Hunziker et al., 1998).

Echinochloa P. Beauv., a pantropical genus of approximately 40 species (Clayton & Renvoize, 1986), has a base chromosome number of $x = 9$ and tetraploid, hexaploid, and dodecaploid cytotypes (Watson & Dallwitz, 1992). A new hexaploid count, with $2n = 54$, is reported here for *E. polystachya* (Kunth) Hitche. var. *polystachya*; previous reports for this species are an approximate dodecaploid count of $2n = 108$ (Pohl & Davidse, 1971) and subsequently its confirmation as $n = 54$ (Davidse & Pohl, 1974). The genus is distinguished by its racemose inflorescences, with spikelets unilaterally arranged; spikelets with lower glume short, upper glume and

lower lemma acute to awned; and upper antheridium indurate, smooth and shiny, with the apex of the palea reflexed.

Eriochloa comprises about 30 species of moist grasslands and open woodlands in tropical, subtropical, and warm temperate regions of both hemispheres (Clayton & Renvoize, 1986). The genus is distinguished by the presence of a basal swelling, which is the fusion of the vestigial lower glume with the rachilla internode. The basic chromosome number of the genus is $x = 9$, and tetraploid, hexaploid, and octoploid cytotypes have been reported (Watson & Dallwitz, 1992). A chromosome count of $2n = 18$ was found in *E. distachya* Kunth, in agreement with previous diploid reports (Pohl & Davidse, 1971; Norrmann et al., 1994). Also, three counts are reported here for *E. punctata*: $2n = 36$ (Fig. 1A), which agree with previous tetraploid reports (Núñez, 1952; Gould, 1966; Gould & Soderstrom, 1967; Quarín, 1977; Hunziker et al., 1998); the other two counts, $2n = 18$ and $2n = 72$, represent new diploid and octoploid levels for the species.

Hymenachne P. Beauv. is a small genus with approximately 10 worldwide distributed species in tropical wetlands (Watson & Dallwitz, 1992; Aliscioni et al., 2003). The genus is distinguished by having aquatic plants, with inflorescences with racemose branches, spikelets unilaterally disposed, and spikelets with upper antheridium membranous, the margins of the lemma flat, leaving the apex of the palea exposed. The basic chromosome number for the genus is presumed to be $x = 10$, although there are previous counts of $n = 18$ (Sindhe et al., 1975; Sharma et al., 1978) and $2n = 24$ (Gould & Soderstrom, 1970). *Hymenachne donacifolia* (Raddi) Chase is reported herein as a diploid cytotype ($2n = \text{ca. } 20$); previous counts for the species are $2n = 24$ and $2n = 40$ (Gould & Soderstrom, 1970; Pohl & Davidse, 1971; Honfi et al., 1991).

The genus *Ichnanthus* P. Beauv. comprises about 33 species mainly distributed in tropical regions of the New World. The genus is distinguished by having a lower glume that is 1/2 to 1× the length of the spikelet and the presence of conspicuous wings, or scars, at the base of the upper lemma. Its basic chromosome number is $x = 10$, and aneuploidy, as well as tetraploid and hexaploid cytotypes, were reported for some species (Gould & Soderstrom, 1967; Pohl & Davidse, 1971; Honfi et al., 1991; Hunziker et al., 1998; Watson & Dallwitz, 1992). *Ichnanthus procurrens* (Nees ex Trin.) Swallen of section *Foveolatus* Pilg. (Stieber, 1987) is a diploid cytotype with $2n = 20$; this count is in agreement with that of a previous report (Gould & Soderstrom, 1967).

Mesosetum Steud. is a genus with nearly 35 American species, mostly distributed in South America, with a few representatives in the West Indies and Central America (Filgueiras, 1989). The genus is distinguished by the inflorescence being a solitary raceme, with spikelets solitary, the upper antherium indurate, open at the apex, and the caryopsis with a linear hilum. Although few counts have been reported for the genus (Gould, 1966; Gould & Soderstrom, 1967; Pohl & Davidse, 1971; Davidse & Pohl, 1972), they suggest that the basic chromosome number of *Mesosetum* is $x = 8$. Our chromosome count for *M. loliforme* (Hochst. ex Steud.) Chase, $2n = 32$, agrees with that of a previous report (Gould & Soderstrom, 1967).

Panicum L., s.l., has nearly 450 species worldwide, distributed mainly in tropical and subtropical regions (Webster, 1988). Basic chromosome numbers proposed for the genus are $x = 7, 9$, and 10 (Watson & Dallwitz, 1992), although *Panicum*, in the strict sense restricted to subgenus *Panicum*, has a basic chromosome number of $x = 9$. The count $2n = 30$ for *P. elephantipes* Nees ex Trin. from subgenus *Panicum*, section *Dichotomiflora* (Hitchc. & Chase) Honda (Zuloaga, 1987), is in agreement with previous reports of $2n = 30$ (Covas, 1949; Núñez, 1952; Urbani, 1990). *Panicum trichanthum* Nees of section *Parvifolia* Hitchc. & Chase ex Pilg. (Zuloaga, 1987) showed 36 bivalents (II) and also 35 bivalents (II) plus two univalents (I). This is the first report of an octoploid cytotype for the species. Previous reported counts correspond to tetraploid cytotypes (Pohl & Davidse, 1971; Davidse & Pohl, 1972; Honfi et al., 1991; Norrmann et al., 1994; Morrone et al., 2006). Section *Dichotomiflora* is characterized by including annual or perennial species, aquatic or from humid areas, spikelets glabrous, with the lower glume reduced, 1/5 to 1/3 the length of the spikelet. On the other hand, section *Parvifolia* includes species with open, lax inflorescences, spikelets obovoid to lanceolate, upper glume and lower lemma 5-nerved, and upper antherium indurate, with bottle-like microhairs and simple papillae all over its surface.

The recently established genus *Parodiophyllochloa* (Morrone et al., 2008) includes six American species of tropical and subtropical regions, usually present in the interior of forests or forest edges. This genus departs from *Panicum* s. str. because its species grow at the edge of forests and are characterized by membranous ligules, the presence of cleistogamous inflorescences, and upper antherium mucronate, with simple papillae all over its surface. *Parodiophyllochloa cordovensis* (E. Fourn.) Zuloaga & Morrone is a diploid cytotype with $2n = 18$ (Fig. 1H). Previous counts for the species, under *Panicum cordovense* E.

Fourn., are $2n = 54$ (Pohl & Davidse, 1971) and $n = 27$ (Davidse & Pohl, 1978).

The genus *Paspalum* comprises approximately 310 primarily American species, most with a base chromosome number of $x = 10$ (Burson, 1975). The genus is distinguished by its racemose inflorescences, with spikelets arranged unilaterally on the racemes, with lower glume absent, occasionally reduced. Polyploidy, mainly tetraploidy, is frequent within the genus (Quarín, 1992; Pagliarini et al., 2001). Within *Paspalum*, subgenus *Ceresia* (Pers.) Rchb. includes 25 species distributed from Mexico to southern South America in Argentina and Uruguay (Denham et al., 2002). This subgenus has been characterized by having inflorescences with one to several racemes, the rachis of the racemes is winged and hyaline to membranous, and the spikelet is usually pilose, with the upper lemma not enclosing the tip of the upper palea. A diploid cytotype with $2n = 20$ (Fig. 1I) was observed in *P. heterotrichon* Trin., representing the first count for the species. *Paspalum malmeanum* Ekman is a diploid with $2n = 20$ (Fig. 1J), which confirms a previous report for this species (Killeen, 1990).

Subgenus *Harpostachys* (Trin.) S. Denham of *Paspalum* is characterized by the presence of terminal and axillary inflorescences in the upper foliar sheaths, solitary racemes, and spikelets with lower glume present; it includes 39 American species (Denham, 2005). Within this subgenus, the count $2n = 40$ for *P. campylostachyum* (Hack.) S. Denham is in agreement with a previous report (under *Thrasya campylostachya* (Hack.) Chase [Davidse & Pohl, 1972]). The chromosome number ($2n = 20$) found in two individuals of *P. pilosum* is the first report of a diploid cytotype for the species; tetraploid cytotypes were cited by Pohl and Davidse (1971) and Davidse and Pohl (1974). A count of $2n = 60$ for *P. inconstans* Chase agrees with the report from Morrone et al. (2006). Two individuals of *P. robustum* were analyzed; one of them has $2n = 40$, while the remaining has $2n = 80$, both representing first reports of tetraploid and octoploid cytotypes, respectively. It should be mentioned that a previous count, under *T. robusta* Hitchc. & Chase (Pohl & Davidse, 1971), corresponds to a hexaploid cytotype.

Within subgenus *Paspalum*, the group *Livida* (Chase, ined.) includes caespitose and decumbent perennials with compressed culms, flat blades, and paired, smooth or scabrous spikelets (Chase, 1929; Zuloaga & Morrone, 2005). Three species from Chase's *Livida* group were herein investigated, *P. alcalinum* Mez, *P. denticulatum*, and *P. remotum* J. Rémy. The count $2n = 40$ for *P. alcalinum* confirms a previous report (Dandin & Chennaveeraiah, 1983) and differs from that of Parodi (1946), who reported $2n =$

76. *Paspalum denticulatum* is a widespread American species with highly variable vegetative and floral characters (cf. Zuloaga & Morrone, 2005). Five different individuals of *P. denticulatum* were analyzed: four accessions showed $2n = 40$, in agreement with the tetraploid cytotypes previously reported (Quarín et al., 1982; Quarín & Burson, 1991; Hunziker et al., 1998), and the fifth represents a diploid cytotype ($2n = 20$), which is a novel ploidy level for the taxon. One individual of *P. remotum* was investigated here and showed a tetraploid cytotype ($2n = 40$), which differed from the report from Hunziker et al. (1998), who found an octoploid cytotype for this species.

The informal group *Quadrifaria* Barreto of *Paspalum* (Zuloaga & Morrone, 2005) includes tall caespitose species with a stramineous upper antherium. The examined collection of *P. arundinaceum* Poir., a diploid with $2n = 20$, is reported here for the first time, differing from the previous reports for this species: $n = 30$ (Davidse & Pohl, 1974), $2n = 40$ (under *P. secans* Hitchc. & Chase; Snyder, 1953), and $2n = 80$ (under *P. secans*; Gould & Soderstrom, 1967). Meiotic irregularities, such as the presence of four to eight univalents, were observed in several cells; a similar irregular pairing with different numbers of tetravalents and univalents was also reported (Davidse & Pohl, 1974) in this species. An accession of *P. arundinellum* Mez from Argentina has $2n = \text{ca. } 50$, which is in agreement with a previous report for this species (Honfi et al., 1991). The count of $2n = 40$ for *P. intermedium* Munro ex Morong & Britton corresponds with the reports published by Norrmann et al. (1989, 1994). *Paspalum plenum* Chase is a tetraploid species ($2n = 40$) and shows a meiotic configuration composed of 11 II + 18 I. The chromosome number is in agreement with previous reports (Davidse & Pohl, 1972; Norrmann et al., 1994).

Paspalum regnellii Mez and *P. commune* Lillo are members of Chase's informal group *Virgata* (Chase, ined.; Zuloaga & Morrone, 2005, a detail of Chase groups can be found in the latter paper), which is characterized by including tall species with truncate inflorescences and a dark upper antherium. One examined accession of *P. regnellii* is a diploid with $2n = \text{ca. } 20$ and differs from tetraploid cytotypes of $2n = 40$ reported by Norrmann (1981) and Honfi et al. (1991). *Paspalum commune* is a tetraploid with $2n = 40$, in agreement with previous counts recorded by Saura (1941, 1948) and Hunziker et al. (1998).

Three species were examined in Chase's species group *Plicatula* (Chase, ined.) of subgenus *Paspalum* (Chase, 1929; Zuloaga & Morrone, 2005): *P. atratum* Swallen, *P. geminiflorum* Steud., and *P. plicatulum*.

Species in this group are perennial or annual, terrestrial, in wet lands, and have inflorescences with numerous stiff racemes, spikelets plano-convex, and upper antherium dark brown. The specimen studied of *P. atratum*, from Bolivia, is a diploid with $2n = 20$ (Fig. 1E), which differs from previous counts published by Quarín et al. (1997), Takayama et al. (1998), and Adamowski et al. (2005), who reported $2n = 40$ for this species. *Paspalum geminiflorum* is a diploid with $2n = \text{ca. } 20$ (Fig. 1D), the first count for the species. The examined accession of *P. plicatulum* is a tetraploid with $2n = 40$, confirming previous counts by Moraes Fernandez et al. (1974), Davidse and Pohl (1972, 1974), Honfi et al. (1991), and Pozzobon et al. (2000).

The informal group *Notata* (Chase, ined.), which includes 21 American species (Zuloaga et al., 2004), is characterized by inflorescences usually with two conjugate racemes and a solitary, glabrous or pilose spikelet. *Paspalum ionanthum* Chase is a tetraploid with $2n = 40$, confirming this result with previously reported counts (Quarín & Norrmann, 1987; Pozzobon et al., 2000). *Paspalum maculosum* Trin. is a diploid cytotype with $2n = 20$, in accordance with the report of Norrmann et al. (1994).

Paspalum macrophyllum Kunth, a member of the group *Macrophylla* (Chase, ined.), is a species characterized by its flat leaves, paired spikelets, and the stramineous upper antherium; the taxon is found in Andean regions of Venezuela, Colombia, and Ecuador, at forest edges and in disturbed areas. The accession of *P. macrophyllum*, from Venezuela, is a tetraploid with $2n = 40$ (Fig. 1F), a count that differs from previous reports for the species of $2n = 60$ (Snyder, 1953; Davidse & Pohl, 1974).

The group *Parvifolia* within *Paspalum* (Chase, 1929, ined.; Zuloaga & Morrone, 2005), with approximately nine American species, includes species with inflorescences with delicate racemes and minute, solitary or paired spikelets. Within this group, our count $2n = 20$ for *P. multicaule* Poir. is in agreement with that of previous reports (Davidse & Pohl, 1972; Killeen, 1990). A Venezuelan *P. microstachyum* J. Presl accession is a tetraploid with $2n = 40$, a count that differs from other published ones that found individuals with $2n = 20$ (Pohl & Davidse, 1971; Davidse & Pohl, 1974).

Paspalum penicillatum Hook. f., a member of group *Racemosa* within subgenus *Paspalum* (Morrone et al., 1995b), is a tetraploid with $2n = 40$ (Fig. 1G), in accordance with a previous report published by Morrone et al. (2006) for this species. The group is distinguished by including annual plants; inflorescences with deciduous racemes at maturity; spikelets solitary, glabrous, and plano-convex, with the upper

glume and lower lemma 3-nerved; and the presence of distinctive Kranz cells.

The group *Dissecta* of subgenus *Paspalum* (Chase, 1929; Morrone et al., 1996) includes perennial, aquatic or subaquatic taxa, which all have foliaceous rachises of the racemes and solitary spikelets; species of this group are distributed from the United States to Argentina. *Paspalum repens* P. J. Bergius has $2n = 20$, a result that agrees with previous studies made by Davidse and Pohl (1974).

Paspalum juergensii Hack., a species of Chase's group *Paniculata* (Chase, 1929; Zuloaga & Morrone, 2005), is a diploid with $2n = 20$, in agreement with previous results for this species (Moraes Fernandez et al., 1974; Burson & Quarín, 1982; Morrone et al., 2006). This group is characterized by having plants perennial; inflorescences with numerous racemes; paired spikelets, obovoid to ellipsoid, and usually ferruginous; and upper anthecium pale and shiny.

Pennisetum Rich. is a genus with about 80 species worldwide that are distributed in tropical and subtropical regions. The genus is distinguished by having spikelets on contracted axes to paniculate, the spikelets surrounded at their bases by reduced-branched bristles, the bristles basally free, or partially united, falling together with the spikelets. *Pennisetum latifolium* Spreng. has $2n = 36$, which agrees with previous results published by Parodi (1946) and Núñez (1952). *Pennisetum montanum* (Griseb.) Hack. is a tetraploid species with $2n = 32$. The examined specimen exhibits an irregular meiotic configuration (2 IV + 12 II), an anomaly already cited by Hunziker et al. (1998). The count of $2n = \text{ca. } 36$ for *P. nervosum* (Nees) Trin. is in accordance with Parodi (1946) and Núñez (1952).

Setaria is a genus of ca. 110 species distributed in tropical and warm temperate regions. This genus is distinguished by the presence of one to many bristles, persisting on the axis, below the spikelets, and upper anthecium indurate, usually rugose. The basic chromosome number of the genus is $x = 9$, and polyploidy is a common feature. *Setaria tenacissima* Schrad. ex Schult. is a tetraploid taxon with $2n = 36$ (Fig. 1B); this is the first report for the species. Our count of *S. vulpiseta* (Lam.) Roem. & Schult. is $2n = 18$ (Fig. 1K); this is the first diploid cytotype reported, and this differs from tetraploid (Oliveira Freitas Sacchet, 1980) and hexaploid (Normann et al., 1994) cytotypes, respectively, from previous reports.

As a result of this study, new ploidy levels were found in species of *Echinochloa*, *Eriochloa*, *Hymenachne*, *Panicum*, *Parodiophyllochloa*, *Paspalum*, and *Setaria*. Although only one individual per population was analyzed, the results found in this contribution support, as previously published by Quarín (1994) for

Paspalum, the hypothesis of heteroploidy as a common feature within the grasses. We found only two meiotic configurations with multivalent chromosome associations; one is a count of *Paspalum arundinaceum* and another of *Pennisetum montanum*. Tetraploids, with bivalent meiotic pairing, are the most frequent cytotypes within the analyzed polyploid taxa.

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